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Preliminary Feasibility Study of Resource Recovery Opportunities for Cabarrus County, North Carolina

CSI Resource Systems, Inc.
Boston, MA

Prepared for

Environmental Protection Agency
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A TECHNICAL ASSISTANCE PROGRAM REPORT

PRELIMINARY FEASIBILITY STUDY OF RESOURCE RECOVERY OPPORTUNITIES FOR CABARRUS COUNTY, NORTH CAROLINA

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Technical assistance by personnel teams. 42 USC 6913

RESOURCE RECOVERY AND CONSERVATION PANELS

SEC. 2003. The Administrator shall provide teams of personnel, including Federal, State, and local employees or contractors (hereinafter referred to as "Resource Conservation and Recovery Panels") to provide States and local governments upon request with technical assistance on solid waste management, resource recovery, and resource conservation. Such teams shall include technical, marketing, financial, and institutional specialists, and the services of such teams shall be provided without charge to States or local governments.

This report has been reviewed by the Project Officer, EPA, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Project Officer: Elmer G. Cleveland

PRELIMINARY FEASIBILITY STUDY OF RESOURCE RECOVERY OPPORTUNITIES FOR CABARRUS COUNTY, NORTH CAROLINA

PREPARED FOR
OFFICE OF SOLID WASTE MANAGEMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION IV

BY

CSI RESOURCE SYSTEMS, INC.

SEPTEMBER 1980

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CHAPTER 1. OVERVIEW

Cabarrus County is a primarily rural area of approximately 90,000 persons located in southern North Carolina, about 25 miles northeast of Charlotte. Recognizing that valuable material and energy resources are contained in the solid waste stream, the county is interested in the feasibility of resource recovery from the county's waste. It was this interest, and not the prospect of an imminent waste disposal problem, that led the Cabarrus Board of County Commissioners to request technical assistance from the U.S. Environmental Protection Agency (EPA) in evaluating whether or not resource recovery of the county's solid waste is feasible.*

The evaluation had two overall objectives: first, to determine the technical and economic feasibility of a resource recovery project on a preliminary basis; and second, if the preliminary findings are positive, to identify those immediate next steps that should be performed prior to a commitment of significant additional resources for a comprehensive feasibility study. In conducting this evaluation, several underlying considerations were addressed:

- Because the county does not currently face a landfill disposal capacity problem and because the county landfill operations would have to continue even if a resource recovery project were implemented (although at a greatly reduced waste input volume), the commissioners did not feel it would be realistic to ask the taxpayers to subsidize a resource recovery project. (This subsidy could take the form of either an unrecouped investment or a tip fee to cover annual operating and maintenance costs in excess of the revenues brought in by the project.) In other words, for a project to be considered economically feasible, the resource recovery

*The county's landfill, which is located about 8 miles east of Concord (the Cabarrus County Seat) and about 7 miles southeast of Kannapolis, covering an area of about 225 acres, has an estimated remaining life of about 30 years. Therefore, county officials do not face the disposal crisis that prompts many municipal resource recovery projects. Nonetheless, it is important to note that any existing or future solid waste disposal site is subject to stringent environmental requirements. This study did not address the potential costs involved in meeting these requirements, nor did it address whether, in fact, the existing county landfill can achieve compliance and is, thereby, permitted to remain open over the next 30 years.

PREFACE

This report was prepared for Cabarrus County, North Carolina, under the Technical Assistance and Panels Program, which is conducted by the U.S. Environmental Protection Agency (EPA) to provide assistance to state and local governments. Technical assistance was provided in response to requests submitted to U.S. EPA Region IV by the Cabarrus County Board of County Commissioners.

The report presents the results of a preliminary determination of the feasibility of resource recovery for the county. This determination involved an evaluation of the market potential for energy recovery; the development and evaluation of resource recovery alternatives; and the identification of the major tasks to be performed prior to deciding to implement a resource recovery project. These activities reflect the results of two site visits to Cabarrus County by CSI Resource Systems, Inc. (Resource Systems), and interviews with county and municipal personnel and three industrial energy users in the area.

Resource Systems is a technical assistance contractor to the Office of Solid and Hazardous Waste, U.S. EPA Region IV. Under the terms of the Technical Assistance and Panels Program, all of Resource Systems' technical assistance activities on behalf of Cabarrus County were paid for by EPA.

Resource Systems wishes to thank especially the following individuals for their support and generous cooperation: Charles McGinnis, Cabarrus County Manager; Clifton Bishop, Director of Energy Management at Cannon Mills; Robert Bridgman, General Manager at Specialty Dyers; and Leonard Schenk, Director of Plant Operation at Cabarrus Memorial Hospital.

facility would have to be capable of supporting itself through the revenues generated from the sale of recovered products. This condition for economic feasibility is hereafter referred to as a "zero tip fee" (or a zero disposal charge) at the recovery facility.

- The county was interested in the concept of producing a fuel-grade alcohol from waste as a gasoline substitute for its fleet of vehicles.

- The county was interested in the recovery of methane gas from the solid waste for use in heating various county buildings.

- The county was also interested in the feasibility of using low-pressure, waste-derived steam to heat the various county buildings.

These resource recovery options were preferred by the county because, if feasible, they would provide a direct benefit (in energy and/or dollar savings) to the county.

The work performed in this prefeasibility study was structured to determine if the five basic ingredients essential to project feasibility existed in Cabarrus County. These ingredients are:

- Potentially viable energy buyers whose requirements would use all or most of the usable, or processible, waste generated.*

- A sufficient tonnage of processible solid waste from which enough energy and/or salable materials could be produced to meet the requirements of one or more potentially viable buyer.

- Potentially available sites that are well situated with respect to the shipment of solid waste and the delivery of energy to prospective buyers.

- Resource recovery technologies that can reliably process available waste and produce energy and/or salable materials in the form, quantity, and quality required by prospective buyers.

- Project revenues that will allow the recovery facility to be economically self-supporting (i.e., no tip fee or other subsidy form will be required).

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*Processible solid waste is that tonnage which could be processed in a resource recovery facility. Unprocessible materials include oversized, bulky waste (e.g., large metal objects, bed springs, rugs) and white goods.

To assist Cabarrus County in establishing the feasiblity of the three preferred options, the study initially focused on technology/system alternatives that could use the estimated amount of processible waste available to meet county energy needs and their associated economics.

On the basis of observations by county landfill personnel of solid waste deliveries to the landfill and information contained in county and state studies, it is estimated that approximately 240 tons of solid waste per day, on a 5-day-per-week basis (TPD_5) is delivered to the county landfill (the only disposal facility serving the county). The Philip Morris Company has an option on a parcel of land outside of Concord and is nearing the construction phase for a consolidated manufacturing facility. The results of a preliminary environmental impact assessment indicated that this facility will generate around 24 TPD_5 of industrial-type solid waste. Consequently, when the Philip Morris facility begins operations in a few years, the estimated tonnage of waste delivered to the county landfill should increase to about 264 TPD_5. Because of the processing characteristics of available resource recovery technologies, a portion of this total estimated tonnage of 264 TPD_5 could not be processed in a resource recovery facility. On the basis of other work performed in primarily rural regions, a conservative estimate of 20 percent (or around 52 TPD_5) was assumed to be unprocessible. In addition, because of the preliminary nature of the waste generation estimates, an allowance was made for the possibility of a high estimate, resulting in an assumed availability of 200 TPD_5 of processible waste in 1984 (the assumed first year of resource recovery plant commercial operations). It is important to note that, while appropriate at the prefeasibility study level, prior to making a decision to pursue resource recovery, it would be necessary to develop a more precise estimate of the available processible tonnage.

As the study proceeded, it became evident that the three preferred resource recovery options (fuel-grade alcohol, methane for heating, and steam for heating) were not feasible for technical, project revenue, economic, and/or recovery potential reasons. Consequently,

the study focus changed to one of identifying a viable resource recovery option(s) that could reliably and economically utilize all or most the estimated processible tonnage and support itself through project revenues, although not necessarily provide a direct benefit to the county. While the county is not likely to subsidize a resource recovery system, county officials have expressed the desire to support a project in other ways, inasmuch as a viable resource recovery project will provide benefits to the citizens of Cabarrus County (e.g., a resource facility could postpone for several more decades the difficult task of finding a new landfill site).

In the remainder of this chapter, the study findings and conclusions are summarized, and immediate next steps are identified. Chapters 2 and 3 present the study findings in more detail. Appendix A lists the references used in the assessment of the potential for methane and alcohol production. Appendix B gives the assumptions used in and the findings of the economic assessment.

FINDINGS/CONCLUSIONS

The findings of this preliminary feasibility study indicate that, although none of the three preferred resource recovery options appears to be feasible, at least one of the noncounty alternatives assessed is technically and economically feasible for Cabarrus County. This conclusion is based on the following:

- Cabarrus County appears to have a sufficient tonnage of processible waste available (about 200 TPD_5, or 52,000 tons per year) to support a resource recovery facility.
- A project to produce fuel-grade alcohol (either through direct use of the solid waste as a feedstock, or through use of solid waste as a boiler fuel in distilling alcohol) for use in county vehicles is not practical:
  - The use of solid waste as a feedstock for alcohol production is impractical because only a small portion of the waste stream could be directly converted to alcohol using currently available techniques. Although lab-scale attempts are currently being undertaken to break the larger cellulose portion into fermentable sugars, the technical uncertainties associated with these limited demonstrations are great.

  - The use of Cabarrus County's solid waste as a boiler fuel to produce steam required in alcohol distillation is not economically practical, unless the county wished to become involved in a large-scale manufacturing and marketing enterprise. To utilize fully the energy contained in the county's waste stream, an alcohol plant would have to be sized to produce 120 times the fuel alcohol needed by the county's 57 vehicles. Indications, at this time, are that the county would not be interested in undertaking such an enterprise.

- A project to produce heat for county buildings from solid waste (either through piping recovered methane or generating steam through direct combustion of solid wastes) is not feasible because:

  - The county buildings are not located in proximity to the landfill, such that use of methane for heating would require shipment of the recovered gas through natural gas pipelines. However, the wastes buried in the county landfill are insufficient to justify the large investment in cleaning and pumping equipment that would be required to upgrade the gas so that it could be distributed in natural gas pipelines.

  - The wide seasonal fluctuation in steam demand, the long distances between county buildings, and the low demand relative to the amount of energy contained in the available solid waste present technical and project revenue constraints to the production of steam for heating county buildings.

- A potential industrial user of low-pressure, waste-derived steam exists -- the Cannon Mills Company Plant No. 6 -- whose steam requirements (35,000 pounds per hour of 125-psig steam) are sufficient to utilize substantial portions of the energy contained in the estimated processible tonnage potentially available, and whose current energy use (No. 6 oil) is compatible with the objective of displacing high-cost fuels.*

- A number of vacant sites that may be suitable for a resource recovery facility are within economic steam transport distance of Cannon's Plant No. 6.

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*Cannon's Plant No. 10 in combination with Plant No. 6 constitute another potential steam buyer that could use all of the estimated tonnage of processible waste.

- A modular combustion unit (MCU) system with a design capacity of 200 TPD (four 50-TPD units) and an annual average throughput of about 167 TPD_5 could be used to produce steam to meet the potential buyer's requirement.* An estimated average of 33 TPD_5 would be bypassed to account for estimated seasonal fluctuations in both waste composition and quantity and in user demand.** During the winter months, almost all of the county's available waste would be processed in the MCU-based resource recovery facility. This system was sized based on the preliminary estimates developed as part of this prefeasibility study; however, because these estimates need further refinement, the 167-TPD_5 MCU-based system should be considered as illustrative only.

- An MCU-based system to service Plant No. 6 appears to be economically feasible (i.e., at a zero tip fee) on the basis of a preliminary analysis of several combinations of equity and industrial revenue bond (IRB) financing. Equity could either be provided by Cannon or by another private-sector company.

- An MCU-based system at Cannon compares favorably with continued primary reliance on landfilling in several respects.

  - At a zero tip fee, the county would save on disposal costs by handling less waste at the landfill.

  - The life of the existing landfill could be extended significantly.

  - Cannon would gain a locally produced cost-competitive and secure alternative energy source compared to its current use of residual oil.

  - Several industrial-sector jobs would be created.

  - Resource recovery is an environmentally sound disposal method.

IMMEDIATE NEXT STEPS

The findings and conclusions listed above are preliminary indications of project feasibility; further investigation is necessary to

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*Design capacity is the manufacturer's rated capacity of the waste processing equipment. Annual average throughput is the amount of waste processed by the system on a 5-day-per-week basis averaged throughout the year.

**Bypassed waste is that portion of the processible waste which does not enter the system and goes directly to the landfill.

determine whether the project can in fact be implemented. Specifically, three critical tasks must be performed to verify the preliminary findings, before commiting substantial resources to implement a resource recovery project. These next steps are:

1. Ascertain the level of interest of the Cannon Mills Company and the company's assessment of the project. Obtain more detailed information on its energy practices and requirements, including detailed energy load profiles showing hourly, daily, and seasonal variations; aggregate current and projected fuel costs; and electrical, water, and other utility charges.

2. Establish a weighing and sorting program in Cabarrus County to ascertain that a sufficient amount of solid waste with a sufficient energy value is available to satisfy the requirements of the potential energy buyer. In addition, determine the seasonal fluctuations in waste quantity and composition.

3. Determine whether the county controls the various portions of the waste stream generated within the county and develop strategies to ensure that the waste can be directed to a resource recovery facility.

If these three tasks confirm the feasibility of the identified project, a detailed feasibility study should be performed. Given that this project, were it to be implemented, would involve private-sector financing of a facility using municipal solid waste, it seems appropriate that any additional work should be a cooperative effort by Cannon Mills and Cabarrus County. A detailed feasibility study will enable Cannon and the county to decide whether to proceed toward resolving project implementation issues, including system performance requirements, system size optimization (e.g., whether to service Plant No. 6 alone or both Plants Nos. 6 and 10), risk management, procurement, and financing.

In considering this project, Cabarrus County should also be aware that:

- A substantial portion of the solid waste stream will require ultimate landfill disposal, even if resource recovery is implemented. This portion may be as high as 45 percent on a tonnage basis if a recovery facility serving Plant No. 6 only was implemented (on a volume basis, the critical measure for determining landfill requirements, this percent would be slightly lower). This waste includes

oversized, bulky materials and noncombustibles that are diverted from the project, residues of combustion, and processible wastes generated in excess of the energy requirements of Plant No. 6.

- Whether resource recovery is implemented or not, the county landfill must achieve compliance with stringent environmental requirements if it is to continue operating.

- The lead time for a resource recovery project is significant. For example, development of an MCU-based system normally requires at least 24 months after formal contract signing. This lead time suggests early 1984 as the earliest date for a fully operational system.

CHAPTER 2. RESOURCE RECOVERY ALTERNATIVES

In this chapter, the results of the preliminary feasibility analysis of the various resource recovery options available to Cabarrus County are presented. In identifying options warranting technical, and ultimately economic, analysis, the following parameters were used:

- The facility should be economically self-supporting (i.e., it should have a zero tip fee), because a system requiring a county (taxpayer) subsidy is not realistic given that the existing county landfill has a potentially useful remaining life of 30 years and a current low operating cost.

- In order to derive the greatest benefits from the energy contained in the county's waste stream, the facility should be capable of processing a substantial portion of the approximately 200 TPD_5 of processible waste estimated to be available, and the potential buyer of the waste-derived product should have requirements that would utilize all or most of that product.

- The facility should be based on commercially available and demonstrated resource recovery technologies, such that the technical risks are minimized.

In addition, because the major waste recovery techniques available today are energy recovery technologies and because energy is the most readily extractable and most directly beneficial source from mixed municipal waste, the analysis of resource recovery alternatives addressed energy recovery only.* Energy recovery is also supportive of the county's desire to derive either direct or indirect benefits from a facility. For example, thermal reduction of the processible portion of the solid waste stream in an energy recovery facility can result in a more than 90-percent reduction in the volume of processible waste to be landfilled.

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*Several proven technologies now exist to recover energy from mixed municipal waste, and about 75 percent of municipal waste is combustible. Other waste recovery techniques are available, such as mechanical materials recovery, which does not address the potential energy value of the waste; and composting, which yields a humus-like soil supplement that is commercially less valuable than recovered energy. Materials recovery, while not constituting a major recovery strategy, could readily become a component of an energy recovery system.

Using these parameters, the analysis resulted in the elimination of all three of the county's preferred energy recovery options. However, an assessment of the potential for noncounty buyers of recovered energy indicated that a potential waste supply/market/technology/site match exists for an MCU-based facility with an annual average waste processing throughput of 167 TPD_5 (design capacity of 200 TPD), producing low-pressure steam for use at the Cannon Mills Company Plant No. 6 located in Concord, North Carolina.*

In the following sections, the results of this preliminary assessment are given for both energy recovery technologies servicing county facilities and technologies servicing industrial or institutional facilities.

ENERGY RECOVERY OPTIONS TO MEET COUNTY REQUIREMENTS

As stated previously, the county initially requested technical assistance from EPA to conduct a prefeasibility study of resource recovery options that would directly benefit the county. The preferred options were:

- The production of a fuel-grade alcohol as a fuel substitute for the county fleet of 57 vehicles.
- The use of recovered methane to heat county buildings.
- The use of waste-derived steam to heat county buildings.

Each of the options is discussed below from the point of view of available technologies and the potential of a project to use all or most of the waste available and to be economically self-sufficient.

Fuel-Grade Alcohol

Two possible options were considered for the production of alcohol from the county's solid waste. The first option would involve the direct use of solid waste as a feedstock for alcohol production. The second

*A larger resource recovery plant sized to service both Plants Nos. 6 and 10 may also be feasible. This larger plant would use all of the county's processible waste.

option involved the use of the county's solid waste as a boiler fuel in the alcohol distillation process. The feedstock, in this case, would be grain or similar fermentable materials (putrescibles) commonly used in the production of alcohol in the United States.

The first option was eliminated because the technology that would allow the conversion of the larger portion of the waste stream to alcohol has not yet been fully developed to the point where either the technical obstacles or the economics would be acceptable. Only a small portion of the waste stream (putrescibles) can be practically converted to alcohol; the greater portion of the waste comprises cellulose, which cannot readily or economically be broken down into alcohol. Although it is theoretically possible to produce alcohol from these cellulostic materials, this would require that paper and wood fibers first be separated from the rest of the waste and then turned into fermentable sugar by one of two processes: acid hydrolysis or enzymatic hydrolysis. Once the process has been completed, the subsequent steps are similar to the production of alcohol from starch- and sugar-based materials. Researchers are now attempting to refine the hydrolysis processes (which have been demonstrated at the lab scale only) to make them cost-competitive with more conventional methods of alcohol production. However, because at this point in time such processes are certain to add substantial costs to a fuel-grade alcohol project, alcohol made from cellulose separated from solid waste will have difficulty achieving economic competitiveness with alcohol made from traditional feedstocks. If, on the other hand, a facility were developed to produce alcohol from the putrescible portion of the waste stream only, the energy value of the greater portion of the waste stream would not be exploited.

Although technically feasible, the second option (use of waste-derived steam as a boiler fuel in the distillation process) would not allow full recovery of the energy contained in the waste stream, given the projected fuel use for the county fleet, unless the county wished to become involved in a large-scale alcohol manufacturing and marketing enterprise. Processing the estimated total of 200 TPD_5 of waste available in the county would provide an alcohol plant with enough steam to

produce some 7.5 million gallons of fuel-grade alcohol each year.* The county fleet, comprising 57 vehicles, with an estimated total of 750,000 to 850,000 vehicle miles per year (15,000 per vehicle), could only use approximately 0.8 percent (or 60,000 gallons) of the total alcohol fuel that could be produced, and indications are that the county would not be interested in marketing the remainder. If, on the other hand, a plant were sized to produce the amount of alcohol that could be consumed by the county, the energy potential of the waste stream would be underutilized. Appendix A lists references used in the assessment of the feasibility of alcohol production.

Methane Recovery for Heating

This recovery option was eliminated from further consideration because neither of the two technically feasible options for methane recovery is appropriate, given the characteristics of the county landfill.

The state-of-the-art for methane recovery from landfilled solid wastes is still evolving. However, two basic recovery methods appear to be technically feasible based on the results of a limited number of demonstrations. These methods are:

- Cleaning the raw landfill gases recovered from the landfill in a capital-intensive plant to achieve pipeline-quality gas (pure methane). This gas can then be distributed in natural gas distribution lines. Because this process requires a large capital investment, it is only economically feasible when the landfill is large and deep, such that the amount of methane that can be recovered and cleaned warrants the investment.

- Direct use of the gas recovered from the landfill (which is contaminated with corrosive materials) by a buyer located nearby.** In this case, only a modest investment in equipment and piping is required.

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*This estimate is based on a yield of 4,600 pounds of steam per ton of solid waste, and a consumption of 30 pounds of steam per gallon of alcohol produced. (See Appendix A, Alcohol Reference No. 3.)

**Certain industries are able to burn this raw, contaminated gas continuously as a baseload fuel.

Neither method is appropriate for the county landfill and for the intended use for heating county buildings because: (1) there are insufficient wastes buried in the landfill to justify the large capital investment in cleaning and pumping equipment that is required to upgrade the gas so that it can be distributed in natural gas pipelines, and (2) the location of the county buildings relative to the landfill would not allow for direct use of raw, contaminated gas, even if the existing boilers were able to burn such gas. Noncounty, industrial use of recovered methane in its raw, contaminated form is not feasible either, as there are no large industrial energy buyers located near the landfill.

Steam Production for Heating

This last option was eliminated for both technical and economic reasons. For purposes of waste-derived steam, the most desirable steam customers require relatively low-pressure and low-temperature steam, have a relatively constant steam demand on a 24-hour-per-day basis and a minimum of 5 days per week throughout the year, and currently use high-priced fuels in their boilers.

At the time the county requested technical assistance, it wished to assess the practicality of supplying waste-derived steam heat to some or all of the seven major county buildings (which currently are heated by steam raised in natural-gas-fired boilers). These buildings are: the County Court House Complex, which houses the administrative, financial, and legal activities of the county government; a complex of three buildings on the outskirts of Concord; and three school buildings.

The only potentially practical arrangement for this option would be to build an MCU-based resource recovery plant near the buildings. The county's waste would then be burned to produce steam, which would be piped to any of the buildings within an economically and thermodynamically practical distance (i.e., a 1.5- to 2.0-mile radius). There is, however, a major drawback to this approach. Substantial heating loads only occur in Cabarrus County about 4 or 5 months a year. To be economical, a resource recovery plant must be able to sell all or most of its energy product year-round. As solid waste is generated every day of the year, a plant servicing an intermittent heating load would either

have to dump the excess steam or be operated as an incinerator during most of the year. During these 7 or 8 months, revenues would be insufficient to cover operating and maintenance costs and debt service, such that a tip fee or other subsidy form would be required. Even on the coldest days of the winter, the combined demand of all seven buildings does not approach the amount of steam that could be produced from the estimated average of 200 TPD_5 of solid waste that would be available; i.e., about 40,000 pounds per hour on a 5-day basis. Moreover, the seven county buildings are widespread and not all of them can be connected via an economically sized steam line.

ENERGY RECOVERY OPTIONS TO MEET PRIVATE-SECTOR REQUIREMENTS

Once it became evident that none of the county's preferred options was feasible, an attempt was made to identify potential noncounty users of low-pressure steam whose requirements would provide a better match with the available waste supply and with the performance characteristics of available technologies. (The characteristics of the most desirable steam customers, as delineated in the discussion of steam production for heating county facilities, are applicable for industrial/institutional steam customers as well.) In addition, because the county does not have a waste disposal problem and because a recovery plant would not be servicing county facilities, it seemed appropriate to select potential noncounty buyers that might be interested in investing in the facility.

According to information provided by the county, there are three industrial or institutional entities in the county whose steam and/or hot water demands are large enough to be partially satisfied by waste-derived energy from a resource recovery plant. These potential customers are:

- Cabarrus Memorial Hospital
- Specialty Dyers, Inc.
- Cannon Mills Company.

A visit was made to each potential buyer to determine if: there is a possible match between energy available from the county's waste and the

buyer's requirements; there are resource recovery technologies that are compatible with the requirements of the energy user; there is interest in participating (and, perhaps, investing) in a resource recovery project; and an appropriate site is potentially available nearby.

A summary of the findings for each of these potential buyers is presented in the following subsections.

Cabarrus Memorial Hospital

A 460-bed facility located in Concord, Cabarrus Memorial Hospital is the second largest employer in the county. The hospital produces steam for heating and cooling and hot water on a year-round basis. However, during the summer months, steam demand drops to 6,000 to 8,000 pounds per hour, which is the energy equivalent of less than 40 TPD_5 of solid waste. Resource recovery economics require that virtually all of the energy produced be sold. Thus, a project serving the hospital would have to be sized to serve the summer load; however, steam revenues obtained from a project of this size would be insufficient to cover total annual operating and maintenance costs. Consequently, a tip fee or other form of subsidy would be required. Moreover, during the visit to the hospital, hospital management indicated that a suitable site was not available and that it was concerned about potential air pollution impacts resulting from a resource recovery plant as well as the reliability of such plants. For these reasons, the management is not interested in pursuing a resource recovery project at this time. Therefore, Cabarrus Memorial Hospital was eliminated as a potential market for waste-derived steam or hot water.

Specialty Dyers, Inc.

Specialty Dyers, a commission dyer, operates a plant located in Concord. The plant uses four boilers to generate 120-psig steam and hot water. During the summer, hourly plant energy demand drops to 14,000 to 17,500 pounds of steam, which is equivalent to about 70 to 80 TPD_5 of solid waste -- again, a resource recovery plant sized to meet this minimum demand would not provide sufficient steam revenues to cover the total annual cost of operating and maintaining the facility;

and a sizable subsidy would be required. Although the company indicated an interest in purchasing waste-derived energy, there is some question as to its ability to invest in a resource recovery project because of the heavy competing demands for capital simply to maintain its current level of operations. For these reasons, Dyer was eliminated from further consideration as a viable energy buyer at this time.

Cannon Mills Company

Cannon Mills is one of the 10 largest textile companies in the country. The firm operates 19 plants, 7 of which are located in the Concord-Kannapolis area and together comprise the county's largest employer. Some of these plants consume steam on a 5-day-per-week, 24-hour-per-day basis in quantities that far exceed the amount that could be generated using the county's available waste, and, in that sense, would constitute desirable steam customers. However, because these larger plants currently use coal to generate steam, they would not constitute an attractive energy market from a project revenue point of view, because waste-derived steam priced to that produced from coal would yield revenues that would be insufficient to cover total annual operating and maintenance costs and debt service, unless supported by a tip fee or other form of subsidy.

Two of Cannon's plants, both located in Concord, burn high-cost premium fuels -- oil and natural gas. Plant No. 6 burns residual oil and generates about 35,000 pounds of steam per hour, 5 days a week, 24 hours a day, 250 days a year. Plant No. 10 burns both oil and natural gas to generate about 18,000 pounds of steam per hour.

Of all the potential energy customers in Cabarrus County, Cannon Plants Nos. 6 and 10 appear to offer the greatest chance for success of a resource recovery plant for the following reasons:

- Plant No. 6 alone can accept a large percentage of the energy content of the processible waste generated by the county; Plants No. 6 and 10 together could accept all of the estimated steam that the county's waste stream could supply on an average day. (Combining Plants Nos. 6 and 10 into one energy market would require the installation of an approximately 4,000-foot steam line between them.)

- Energy derived from refuse would displace premium fuels (oil or natural gas) at both plants. Thus, the resource recovery plant revenues would have the greatest chance of covering costs, such that a zero tip fee would be possible.

- There are a number of vacant sites near Plant No. 6 that may be suitable for a resource recovery facility.

- Cannon's Director of Energy Management has indicated that the company could be interested in purchasing energy from a resource recovery plant, given the right circumstances.

- Cannon would be an ideal sponsor of or investor in a recovery facility based on the company's long history of civic projects (e.g., it provides free solid waste collection services to residents of Kannapolis), its partial dependence on scarce and high-priced fuels, and its strong financial position (1979 results -- net worth $317 million and net income $41 million).

For these reasons, the technical and economic feasibility of a project producing low-pressure steam to service Cannon Mills (either Plant No. 6 alone or Plants Nos. 6 and 10 combined) was assessed. Because one of the criteria underlying this assessment was to select a commercially available resource recovery technology, an MCU-based plant with a design capacity of 200 TPD (four 50-TPD units) was selected for this assessment.

In sizing this system, the following assumptions were used:

- The higher heating value of the county's waste is 4,500 Btu per pound.

- System efficiency is 60 percent.

- Steam output is 4,600 pounds per ton of waste with no condensate return.

- 125-psig steam is produced.

- System operates 24 hours per day, 5 days per week, 240 days per year.

- Annual average system throughput is 167 TPD_5 (240 days per year), or 40,080 tons per year.

As Plant No. 6 could consume all of the energy produced by processing an average of 167 TPD_5, a four 50-TPD unit facility is a logical size for illustrative purposes, given the size range of the MCUs available today.

Description of MCU Technology

Steam markets with low demand (i.e., 20,000-80,000 pounds of steam per hour) and, thus, small processing requirements for solid waste (100-400 TPD) can be served by MCUs, which are pre-engineered, factory-assembled systems. MCUs equipped for solid waste processing, energy recovery, and continuous ash removal are available in individual unit sizes ranging from 10 to 75 TPD.

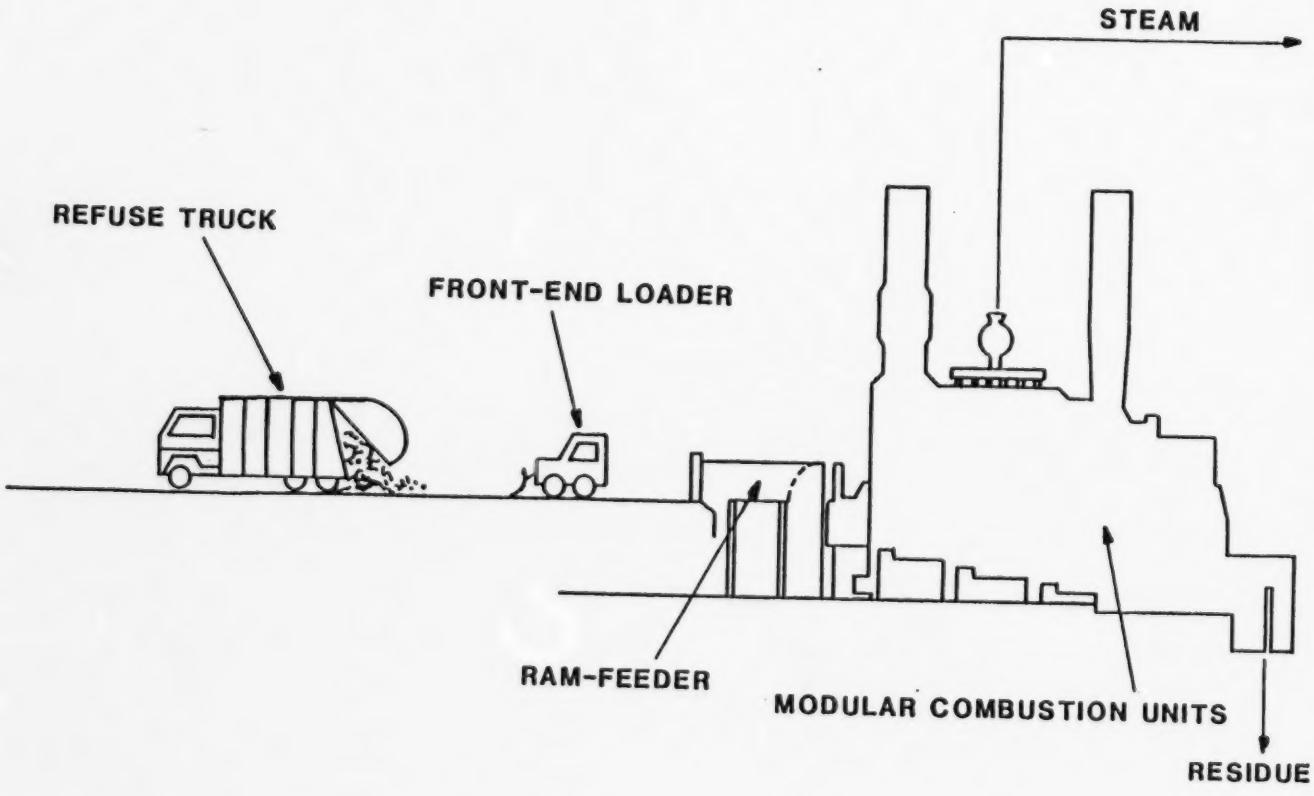
Figure 1 provides a simplified diagram of an MCU. As shown in this figure, waste is delivered to the resource recovery facility, onto a concrete unloading floor. Unprocessible materials (e.g., large metal objects, water heaters, rugs) are removed and placed in residue containers for sale as scrap or for disposal in a landfill. A front-end loader is used to push the remaining solid waste into a hopper, and a hydraulic ram-feeder moves the waste into the incinerator's lower chamber where it is partially burned. The heat released provides the energy needed to dry and gasify the remaining waste. The carbon-monoxide-rich smoke leaves the top of the lower chamber and enters the secondary chamber; there, more air is added, and the gases are burned to completion. As the hot gases exit the secondary chamber, they pass through a heat exchanger (boiler), where the heat in the exit gases is converted to steam. The stack gases are then discharged to the atmosphere.*

Ash consisting of glass, stone, metals, inert solid waste, and uncombusted organics is moved from the bottom of the lower chamber into a water-quenching system, by a periodically activated ash discharge ram. The ash is partially dewatered while being moved up an incline via a drag chain conveyor. A rotating magne. that recovers

*No MCU currently in operation uses a pollution control device. However, increasingly stringent air pollution regulations will likely require the installation of some type of control technology on MCUs.

FIGURE 1

MODULAR COMBUSTION UNIT



magnetic metals for sale to the secondary metal market can be installed. The remaining ash is loaded into a truck for disposal at a landfill.

CHAPTER 3. ECONOMIC ASSESSMENT

As discussed previously, to be considered economically feasible, a resource recovery alternative should have a zero tip fee. In other words, energy revenues should equal or exceed the total annual operating and maintenance and debt service expenses.

For purposes of this assessment, 100-percent equity investment was assumed to be a desirable financing method for the following reasons:

- The characteristics of the project are such that it is more of an "alternative energy" project for Cannon than a solid waste management solution for the county.
- This financing method implies a greater deal of flexibility and control than does industrial revenue bond (IRB) financing.
- Under this financing method, implementation can be expedited by as much as 1 year.
- The return on investment is attractive.

The equity investor could either be Cannon or another private-sector company. If a company other than Cannon were to provide equity investment, however, some of the advantages of central project control would be lost.

The preliminary economic assessment showed that whether the Cannon Plant No. 6 alone or Plants Nos. 6 and 10 were serviced, at 100-percent equity financing, the projected tip fee would be zero beginning with the first year of commercial operations (1984); thus, the plant would become economically self-supporting immediately. Under 100-percent equity, the projected annual average return on investment would be around 14 percent. At 50-percent equity/50-percent IRB and at 25-percent equity/75-percent IRB, the plant would also be immediately self-supporting, and the estimated annual average returns on investment would be about 23 and 27 percent, respectively. However, Cannon (if it were the equity investor) would have less flexibility and control, implementation would take longer, and the company would only be eligible for a 10-percent investment tax credit, and not the additional 10-percent energy tax credit. (This factor has already been taken into account in estimating the returns.)

In the remainder of this chapter, the methodology used to conduct this prefeasibility economic assessment, the economic estimates for the

Cannon Mills project, and the assumptions used are summarized. Appendix B gives a more detailed description of the assumptions used in this initial analysis.

METHODOLOGY/FINDINGS

The first question to be addressed was whether project economics are improved or impaired by servicing both Plants No. 6 and No. 10. This determination was made by comparing the incremental revenue produced by displacing fuel at Plant No. 10 (natural gas and No. 6 oil) with the capital cost of the steam line that would be required to service this second plant. Because this comparison indicated almost breakeven costs, it was concluded, for purposes of this preliminary level of analysis, that the economics of servicing the combined plants would be approximately the same as those of servicing Plant No. 6 alone. If a decision is made to conduct additional feasibility work, a more precise determination of the comparative economics should be made at a later stage. At that point, the more attractive alternative can be selected.

The method of financing a project greatly affects its capital and, thus, total costs. To date, IRB financing has been the principal instrument used for private-sector financing of resource recovery projects. However, because 100-percent equity financing allows greater flexibility and control and is more expeditious, this method is becoming more common for private-sector financing of a resource recovery facility. These advantages occur because project responsibility is not shared with a public-sector entity and because it is not necessary to go through the procedures of floating a bond issue. In addition, various combinations of equity and IRB financing are being used. In the case of a Cannon Mills/Cabarrus County project, equity participation by Cannon Mills or another private-sector company appears to be appropriate because the project's major function would be to exploit a locally produced alternative fuel, rather than to solve a county solid waste disposal problem. Therefore, the preliminary economic analysis summarized in this chapter was based on 100-percent equity financing.

For purposes of comparison, three financing arrangements other than 100-percent equity were also assessed that would take advantage of a

somewhat lower interest rate (assumed to be 9 percent). These are:

- 100-percent IRB.
- 75-percent IRB and 25-percent equity.
- 50-percent IRB and 50-percent equity.

The 200-TPD MCU project (annual average throughput would be about 167 TPD_5) was evaluated at 100-percent equity financing using a discounted cash flow analysis and assuming that early 1984 would be the first year of facility operation. On the basis of conservative assumptions regarding project revenues and costs (discussed in the next section), an after-tax return on investment of about 14 percent was estimated. (This result compares favorably with the 13-percent net income reported by Cannon Mills for 1979, which has been the company's best performance in recent years.) Using another method of project justification, the "payback" method, the project would recoup its initial investment in about 5 years. (It is not known, however, whether a 5-year payback period complies with Cannon management's investment requirements.) In other words, under either method of estimating returns on investment, indications are strong that the project would be economically self-supporting immediately.

It should be noted that, were Cannon to undertake 100-percent equity financing of the resource recovery project, the implementation period (development, design, construction, startup, and acceptance testing) could be shortened by as much as 1 year. This would, in turn, expedite the cash flow with corresponding increases in the return on investment. This advantage would likely be lost if a company other than Cannon were to provide equity financing.

The economic estimates for the other three financing methods considered also indicate project feasibility. A net disposal cost (costs minus revenues) was estimated for the 1st and 6th year of operations for the 100-percent IRB alternative. All other cases assume a zero tip fee beginning the 1st year of commercial operations. The table on the following page summarizes the preliminary findings under all four financing options.

Financing Option	Projected Tip Fees 1984	1989	Year Project Becomes Self-Supporting (i.e., a zero tip fee is achieved)	Projected After-Tax Return on Investment
100% IRB*	$11.70	< $3.29 >	1988	N.A.
25% Equity/** 75% IRB	0.00	0.00	Immediately	27.3%
50% Equity/** 50% IRB	0.00	0.00	Immediately	22.7%
100% Equity**	0.00	0.00	Immediately	13.9%

The preliminary projections developed under the 100-percent IRB financing alternative indicate that operating and maintenance and debt service expenses will exceed project revenues for the period of early 1984 to early 1988, up to the 4th year of commercial operations. By early 1988, these costs and the revenues generated will obtain break-even status, and by early 1989 (the beginning of the 5th year of commercial operations), revenues will exceed expenses, i.e., profits will be generated. Consequently, under this financing approach, preliminary indications are that either a tip fee would be required to make up the revenue shortfall or the energy buyer would have to subsidize the product (e.g., by paying a premium price for the energy purchased) up until the 4th year of operation.

Under the 75-percent IRB/25-percent equity financing alternative, preliminary indications are that, because of the significant depreciation tax shelter, even when nondiscounted fuel prices are assumed, the resource recovery facility would provide a very attractive annual after-tax return on investment of around 27 percent. In the 50-percent equity/50-percent IRB case, the annual overall after-tax return on investment was estimated to be around 23 percent. If Cannon or another company were to implement a resource recovery project using these two financing combinations, the company could use the lower interest IRBs as

*Assumes 10-percent discount on fuel.

**Assumes no discount on fuel.

leverage, and obtain a higher return on investment from a much smaller investment. There are certain advantages to the 25-percent, 50-percent, and 100-percent equity approaches; obviously, the decision would be the private-sector investor's as to which approach it might choose.

ASSUMPTIONS

The assumptions used in developing the economic projections (system cost and revenue estimates) are summarized briefly in the following subsections.

Projected System Costs

The 1980 capital costs of an MCU-based system were developed from engineering estimates and recent bids submitted by full-service system vendors. These costs were then projected to 1982 (assumed to be the midpoint of construction) at a compounded annual escalation rate of 14 percent. System operating costs were assumed to escalate at a 10-percent rate. To project the rate of return for the 100-, 50- and 25-percent equity cases, a straight line, 15-year depreciation was assumed with a 45-percent income tax rate.

Projected Revenues

In projecting energy revenues for each alternative, the following assumptions were made:

- The price of the facility's energy output reflects, on a Btu-equivalent basis, the price of the fuel displaced less a 10-percent discount for the 100-percent IRB case. For the 25-percent, 50-percent, and 100-percent equity cases, no fuel discount was assumed. Thus, in these latter three cases, the additional revenue accrues to Cannon as part of the overall return on the investment.

- The displaced fuel was assumed to be 1.5-percent sulfur No. 6 oil with an average 1980 cost of $0.62 per gallon, escalated at a compounded annual rate of 12 percent.

- For a resource recovery plant servicing Cannon Plant No. 6 only, daily average waste throughput is limited by the amount of steam that can be sold, which, in turn, limits the revenues. During all seasons of the year, except possibly winter, it is estimated that the county can provide more than a sufficient tonnage of processible waste to supply the needs of the Cannon Plant No. 6 alone. It was assumed that the resource recovery plant would supply all but 3,000 pounds of steam per hour, allowing Cannon to keep a boiler (new or existing) on line to satisfy demand swings. Steam sales were assumed at an average rate of:

$$\frac{167\ TPD_5\ \text{of MSW} \times 4{,}600\ \text{lbs of steam}}{24\ \text{hrs}} = 32{,}000\ \text{lbs/hr.}$$

- Steam sales were assumed to occur 240 days per year to allow for scheduled and nonscheduled outages at Plant No. 6 and at the resource recovery plant.

- No other revenues were taken into account, such as a tip fee or potential credits for reduced waste hauling costs from Cannon plants or Kannapolis.

APPENDIX A.
REFERENCES

METHANE

1. Eberhart, R., et al., Landfill Methane Utilization Technology Workbook, The Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, 1979.

2. Giuliani, A.J., "Methane Recovery from a Shallow Landfill, Experiences at Fresh Kills, Staten Island, New York." Proceedings of the Fall Program, New York State Association for Solid Waste Management, 1979.

3. Pacey, John and Karpinski, Gail, "Assessing a Landfill's Potential as a Methane Gas Generator," Solid Waste Management/RRS, November 1979, page 26.

ALCOHOL

1. Attendance at Bio-Energy-'80 Conference, Atlanta, Georgia, April 21-24, 1980.

2. Business Week, "Cheap Alcohol from Cellulose," January 14, 1980.

3. Miller, D.R., "Gasohol the NOW Fuel," at Meeting of National Gasohol Commission, Inc., Chicago, Illinois, March 15, 1980.

4. Miller, D.R., "Incorporating Cellulose Feedstocks Along with Starch and Sugar Based Raw Materials for Fuel Grade Alcohol," at Meeting of National Gasohol Commission, Inc., San Antonio, Texas, December 2-5, 1979.

5. National Alcohol Fuels Commission, Urban Waste Program/DOE, Federal Agency and Department Alcohol Fuels Program, 1980.

6. Office of Technologies Assessment, Gasohol, A Technical Memorandum, September 1979.

7. Telephone conversation: Mr. Leo Spanno at the U.S. Army Natick Research and Development Command, Natick, Massachusetts.

APPENDIX B.
ECONOMIC AND FINANCING
ASSUMPTIONS AND PROJECTIONS

In this appendix, the assumptions used and the projections made in the preliminary economic analysis are given. The economic and financing assumptions used are listed in Tables B-1 and B-2, respectively. Table B-3 gives the economic projections for the illustrative 200-TPD MCU-based system assuming 100-percent equity financing.

TABLE B-1

ECONOMIC ASSUMPTIONS

- Annual escalation rates:
  - 14 percent for construction costs to midpoint of construction (1982)
  - 12 percent for energy revenues
  - 10 percent for operating costs.
- Energy values received for displaced energy:
  - 10-percent discount for 100-percent IRB case.
  - No discount for 25-, 50-, and 100-percent equity cases.
- Steam value in 1984 (Btu-equivalent basis): $10.13 per 1,000 pounds.

TABLE B-2
FINANCING ASSUMPTIONS

100-Percent IRB

- 17.5-year bond issue; interest payments only during 2.5-year construction and startup period.
- 9-percent interest.
- Debt service reserve account: a reserve fund equal to 1 year's debt service.
- Capitalized interest account: a reserve fund to meet interest payments on bonds during construction and startup, when energy revenues are not available.
- Bond financing: bond issue costs and underwriter fees equivalent to 3 percent of total bond issue.

25-Percent Equity/75-Percent IRB

- Equity investment equivalent to 25 percent of capital, contingency, and engineering costs.
- Other assumptions identical to those for 100-percent IRB financing.

50-Percent Equity/50-Percent IRB

- Equity investment equivalent to 50 percent of capital, contingency, and engineering costs.
- Other assumptions identical to those for 100-percent IRB financing.

100-Percent Equity

- Equity investment comprises capital, contingency, and engineering costs.
- No requirement for debt service reserve account, capitalized interest account, and bond financing.

TABLE B-3

SYSTEM ECONOMIC PROJECTIONS

200-TPD MCU SYSTEM - 100% EQUITY FINANCING

Energy Market	Cannon Mills Plant No. 6
Throughput	167 TPD_5/ 40,080 TPY
	($000)
Capital Cost (mid-construction period 1982)	$ 6,500
Contingency (7.5 percent)	$ 488
Engineering/Legal Fees	$ 200
Gross Investment	$ 7,188
Investment Tax Credit	<$ 1,439>
Net Investment	$ 5,749
Net Present Value of Investment as of mid-1981	$ 5,010
Annual Operations, First Full Year of Operation (1984)	
- Steam Revenues	$ 1,867
- Operations, maintenance replacement & operator profit	$ 1,106
- Annual depreciation	$ 479
- Profit before tax	$ 282
- Profit after 45% tax	$ 155
- Cash flow first year	$ 634
Internal Rate of Return for 15-year Economic Life	13.9%